

DIGESTIBILITY OF NUTRIENTS BY RABBITS

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ALTHOUGH the rabbit is widely used as a laboratory animal in research and is produced commercially for food, much less is known about its nutrition than that of the rat or the larger species of farm animals. Knowledge of the digestibility of nutrients by any species is useful in understanding their nutrition and in formulating experimental and practical diets. The digestibility of nutrients in a number of feeds has been determined with rabbits and comparisons made with the digestibility by ruminants in efforts to make use of the rabbit as a laboratory animal for ruminant nutrition studies (Hawkins, *et al.*, 1957; Richards, *et al.*, 1962).

Much of the digestibility data obtained with rabbits represent values for individual feeds; yet it is recognized that the degree of digestibility may vary depending in part upon the presence in the diet of nutrients from various sources. Since most rabbit rations are prepared from mixtures of ingredients, it is desirable to measure the digestibility of the nutrients in a complete ration. The purpose of the present paper is to review briefly the available data on nutrient digestibility by rabbits and to present data on the digestibility of nutrients in a complete ration by two ages of rabbits.

All segments of the alimentary tract of the rabbit are functional in the digestive process. Alexander and Chowdhury (1958) have shown that, in addition to enzymatic digestion in the stomach, some fermentation takes place in this organ and other work has shown that the lactic acid produced may be utilized by the rabbit (Drury and Wick, 1956). Other fermentation products of the lower intestinal tract are made available to the rabbit in the normal practice of coprophagy (Kulwich, *et al.*, 1953; Huang, *et al.*, 1954), and coprophagy permits greater digestibility of nutrients (Thacker and Brandt, 1955; Huang, *et al.*, 1954).

Since the rabbit is herbivorous and normally consumes fairly large amounts of crude fiber, the digestion of this nutrient is of importance. Most studies have indicated that crude fiber is not as completely digested by rabbits as by ruminants, but there is less difference in the digestibility of other nutrients. Considerable variability has been observed in the digestion of crude fiber of different feeds by rabbits, and the fiber in green, succulent feeds

was found to be more digestible than that in dried forage (Aitken and Wilson, 1962). It has been generally assumed that much of the digestion of crude fiber takes place in the cecum; however, Herndon and Hove (1955) have successfully removed the cecum from rabbits and observed that digestion of cellulose was not significantly altered.

Rabbit rations normally contain relatively small amounts of fat, yet digestibility studies have shown that this nutrient is highly digestible. Thacker (1956) fed purified diets containing 5 to 25 per cent fat and observed an apparent digestibility of 97 per cent or better at all levels. Considerable variability has been noted in the digestibility of fat in natural feeds (Aitken and Wilson, 1962) but fat digestion in most feeds was relatively high.

A number of other studies concerning nutrient digestibility by rabbits have been reviewed in a report by Aitken and Wilson (1962).

EXPERIMENTAL

New Zealand White and Dutch rabbits of both sexes were used in these studies. Digestion coefficients were determined in two age groups—young animals (5 to 8 weeks old), and adult rabbits.

The diet was a complete commercial pelleted ration which by analysis contained, in per cent: protein, 16.01; ether extract, 2.09; crude fiber, 10.95; nitrogen free extract, 55.96; and energy, 3839 Calories per kilogram. During a one-week preliminary period and the experimental period, rabbits were fed a constant daily amount of feed based upon body weight. The amount for young rabbits permitted normal weight gains; the amount for adult animals was limited to that which permitted slight weight gain. During the 7-day fecal collection period, rabbits were confined to metabolism cages which provided separation and quantitative collection of feces, but did not prevent coprophagy.

Chemical analyses for the various nutrients in the feed and feces were made using methods outlined by the Association of Official Agricultural Chemists (1955). Gross energy was determined in an adiabatic bomb calorimeter. Digestion coefficients were calculated by the conventional method (Maynard and Loosli, 1962) as apparent digestibility, since no correction was made for metabolic fecal nitrogen.

Statistical analyses of the data to evaluate differences between age groups were made by the analysis of variance according to Snedecor (1956).

RESULTS AND DISCUSSION

Digestion coefficients for the various nutrients in the complete ration for both ages of rabbits are recorded in table 1. The values

TABLE 1

Digestion Coefficients for Nutrients in a Complete Ration by Rabbits

Age	No. Rabbits	Dry Matter	Protein	Ether Extract	N.F.E. ¹	Crude Fiber	Energy
5-8 weeks	12	68.5	78.7**	84.3°	79.8	13.3	67.9
Adult	12	66.9	72.9	80.3	79.7	18.7	67.0

¹ Seven rabbits each group.

°Significantly greater at 5% level.

**Significantly greater at 1% level.

for each group represent averages for the number of individual trials in each group. No differences between breeds were observed and data for both breeds were pooled.

The average fat digestibility of approximately 82 per cent was higher than that for other nutrients. Crude fiber, with a mean coefficient of 16, was least digested. Digestibility of other nutrients for both groups combined was: dry matter, 67; protein, 75; nitrogen free extract, 80; and energy, 67.

Significant differences between ages were noted in the digestibility of protein and fat. Young rabbits digested significantly more ($P < 0.01$) protein than adult animals, and the higher digestion of fat by young rabbits was significant at the 0.05 level. Differences between ages for the other nutrients were not statistically significant. The amount of crude fiber digested by the adult rabbits appeared to be greater than for the young, but there was considerable variation among animals in each group, and the mean difference was not significant.

The low digestibility of crude fiber and relatively high digestibility of fat would appear to be of importance in evaluation of the

data. Most commercial rabbit rations contain approximately 15 to 20 per cent crude fiber and a much lower quantity of fat, normally 2 to 3 per cent. Some fiber is considered desirable for normal functioning of the intestinal tract, but the poor utilization suggests the desirability of reducing the amount to a lower level consistent with the level needed for normal intestinal function. On the other hand, the relatively high digestibility of and tolerance for fat may suggest the possibility of increasing the fat content in order to provide a greater intake of energy for growing rabbits. Experiments are planned for further study of the effect of varying levels of fat and of crude fiber in rabbit rations.

SUMMARY

Reports of experiments dealing with nutrient digestibility by rabbits have been reviewed. The digestibility of nutrients in a complete rabbit ration by rabbits of two ages was determined. Fat was digested to the greatest degree; crude fiber least. Protein and fat were digested to a significantly greater degree by young rabbits than by adult rabbits.

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PLEISTOCENE BIRDS FROM AMERICAN FALLS, IDAHO

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AN extinct stork, *Ciconia maltha* Miller, is the only bird recorded from the late Pleistocene American Falls lake beds in southeastern Idaho (Howard, 1942). More recently Marie L. Hopkins, with support from the National Science Foundation, has been collecting along the southeastern shore of the American Falls Reservoir in Power County, approximately 10 miles northeast of the town of American Falls. Vertebrate fossils, including several extinct species of mammals, occur in Bed B (Hopkins and Butler, 1961, fig. 3), which has been dated as having an age greater than 29,700 b.p. Miss Hopkins has asked me to determine the birds, which include the seven species listed below and preserved in the Idaho State College Museum.

- Ardea herodias* Linnaeus. Great Blue Heron. Tarsometatarsus, juv.
Anser caerulescens (Linnaeus). Snow or Blue Goose. Left humerus.
Anas platyrhynchos Linnaeus. Mallard. Left coracoid, left humerus, and left tibiotarsus.
Mergus merganser Linnaeus. Common Merganser. Right tarsometatarsus.
Falco peregrinus Tunstall. Peregrine Falcon. Right humerus.
Bonasa umbellus (Linnaeus). Ruffed Grouse. Right carpometacarpus.
Agelaius phoeniceus (Linnaeus). Red-winged Blackbird. Left coracoid.

These birds all occur locally today, although only the mallard has previously been recorded as a fossil from Idaho (Brodkorb, 1958). All except the grouse frequent aquatic situations.

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